FHWA Contacts: Joe DeLorenzo, HRC-MW, (708) 283-3572; Ken Rodgers, HMSA-10, (202) 366-4016

Hazardous Materials Risk Assessment: Phase I

Introduction

The U.S. Department of Transportation (USDOT) strategic plan has recognized safety as its most important strategic goal. The USDOT is committed to reducing the rate and severity of transportation fatalities and injuries in hazardous materials (HM) transportation and to reducing the dollar loss from high-consequence transportation crashes.

This two-phase Hazardous Materials Risk Assessment project was designed to assist the USDOT in achieving these strategic goals. The project will examine the total impact of commercial vehicle transportation and determine what part of the total is a result of HM transportation (by HM hazard class). The results will be used to evaluate the HM program within the Federal Highway Administration, Office of Motor Carrier and Highway Safety (OMCHS). It will also assist the agency with program development and strategic planning. Included in this process, will be an evaluation of the possibility of a role for HM risk in the SafeStat algorithm, used as a selection tool for conducting compliance reviews.

The completed Phase I characterized the shipment impacts for 1 year of Class 3 HM shipments (flammable and combustible liquids). It also assessed the feasibility of conducting a comprehensive risk assessment of HM and non-HM shipments. Phase II will be the actual comparative risk assessment between HM and non-HM truck shipments broken down by hazard class, as specified in the Code of Federal Regulations (49 CFR).

The Phase I portrait of HM crashes and incidents focused on estimating the impacts of 1 year of HM transportation for Class 3 HM materials. Class 3 materials were selected because of their relative importance among HM shipments in terms of shipment volume and their potential for causing injuries and damages during a crash; 52 percent of HM shipments are Class 3 materials. This tech brief summarizes the 1-year portrait of HM crashes/incidents and their impacts. For this discussion, an incident is an event in which HM is unintentionally released from a package (49 CFR 171.16).

Purpose

The main purpose of Phase I of this project was to develop a methodology for predicting consequences of HM crashes, such as injuries and property damage. An initial step in developing a risk assessment is to reliably estimate the number of crashes and incidents for a defined period of time. The report documented a process to evaluate the full impact of HM crashes and incidents by sampling a single HM class for 1 year.

Methodology

Estimating Crashes and Incidents

For this phase of the project, an estimate of crashes and incidents was developed for Class 3 HM truck shipments in 1996. The estimate used the Hazardous Materials Information System (HMIS) as the baseline database, and supplemented this

The mission of the Office of Motor Carrier and Highway Safety is to develop and promote, in coordination with other Departmental modes, data-driven, analysis-based, and innovative programs to achieve continuous safety improvements in the Nation's highway system, intermodal connections, and motor carrier operations. The Office of Motor Carrier Research and Standards manages the safety regulatory program and the central research management function for Motor Carrier and Highway Safety.

There are eight major research and technology focus areas: regulatory evaluation and reform; compliance and enforcement; driver training and performance management; driver alertness and fatigue; driver physical qualifications; car-truck proximity; HAZMAT safety and cargo tank integrity; and crash causation and profiling.

HAZMAT safety and cargo tank integrity concentrates on assessments of HAZMAT safety issues, in particular the roll stability and crashworthiness of cargo tanks.

Office of Motor Carrier Research and Standards
400 Seventh Street, SW
HMCS-30: Room 3107
Washington, DC 20590

information with several other sources of data to adjust the incidents and crashes reported in the HMIS to more realistically reflect their actual number in a 1-year period. For the purposes of OMCHS's risk assessment study, the HMIS represents the only national database of HM highway transportation incidents with details of the material, packaging, and consequences involved.

To effectively supplement the HMIS data, researchers selected a sample of eight States on which to focus for a more intensive examination, which included six PRISM (Performance and Registration Information Systems Management) States: Colorado, Indiana, Iowa, Minnesota, Pennsylvania, and Oregon. The PRISM States were chosen because of their focus on improved data quality. In addition, California and Ohio were chosen because of state data sources that were valuable to the study. The HMIS data for these eight States were compared with respect to specific crashes found in one or more of the additional databases, identifying a portion of under-reported crashes.

The search criteria used to identify the 1996 Class 3 HM truck shipments for each database included the following:

- Year = 1996
- Crash (or Incident)
- HM Class = 3
- Placarded Vehicle
- Enroute (traveling from origin to destination)

The study includes both HM crashes (no-spill events) and HM crashes with a release, in addition to incident-only scenarios (loading, unloading, and other spill events with no associated crash). This will allow OMCHS to consider whether even with no spill, HM crashes result in higher consequences than non-HM crashes. After analyzing the data in various databases, the crash count for the eight case-study States was used as a measure to calculate the number of crashes for the nation. The process required four steps:

1. The number of crashes for the eight States was estimated by supplementing the HMIS data with information from other databases.

2. A proportion of the national crashes represented by the eight States was calculated. Commodity flow and truck registration data were used to estimate the portion of the total national HM traffic represented by the eight States. The total commodity ton-miles of HM transport within the eight States represents about 30 percent of the total ton-miles for the United States.

3. The crash estimates for each of the eight States were totaled.

4. The total estimated national crash number was calculated by assuming the additional 70 percent of the national crashes occurred at the same rates and types and then by adding the estimate for the remaining 42 States to the 8-State estimate.

Researchers estimated incidents in a more direct manner. Because the HMIS is the best source for enroute and loading/unloading incidents, HMIS data were used for all 50 States.

Impact Methodology

In order to derive an estimate of annual economic impact of crashes/incidents involving shipments of Class 3 HM, a number of consequences must be taken into consideration. Impact categories were selected that could be compared among the crashes/incidents. These consequences go beyond the traditional consequences studied when dealing with transportation-related crashes and incidents. This was done to develop a more comprehensive picture of the impacts and cost of HM transportation for society.

- Injuries and deaths
- Cleanup costs
- Property damage
- Evacuation
- Product loss
- Traffic incident delay
- Environmental damage

Several sources of information were reviewed to establish reasonable estimates of the economic impact of each consequence. Researchers conducted a comprehensive literature review to identify unit costs that have been used in prior economic evaluation studies related to transportation, environmental health, and safety.

Researchers then tallied the impacts reported in federal and state databases; these were supplemented with information about impacts derived from literature sources and through interviews with knowledgeable sources. Impact numbers not readily available from these sources were modeled in order to develop impact estimates. All impacts were converted to dollar values to enable comparison among the impacts and derive a total impact figure for the sample year of 1996.

Impact Figure Estimates

The HMIS was an important source of impact costs for product loss, cleanup costs, and property damage. Injuries and deaths were valued at the amount the

USDOT would spend to avoid the injury or fatality. These monies can be equated with the costs associated with enhanced safety measures (e.g., regulatory safety programs, design standards, vehicle occupant crash protection) designed to prevent transportation-related fatalities. This averaged $200,000 for crash injuries and $2,000,000 for a fatality. Some portions of the USDOT already use this estimate to assess the cost of avoiding a serious injury or fatality,

Traffic incident delay was established as the total number of people delayed at an incident or crash multiplied by $15 per hour, which takes into account the value of a driver's time and fuel consumption costs. In earlier studies (Grenzeback L.R., et al., 1990), average unit vehicle cost was calculated from a unit cost per vehicle hour of $10.92 (1990 dollars) from the Highway Economic Requirements System: The figure was then adjusted to 1998 dollars. Environmental damage was estimated based on the size of an average spill and the value placed on environmental contamination as determined by an average of 30 settlements. Table 1 provides an example of a specific impact case for a Class 3 HM accident,

Findings

For 1996, the impact in terms of dollars for the estimated Class 3 crashes and incidents was approximately $482,000,000. Injuries and fatalities accounted for about 69 percent of the total cost. Carrier damage and incident delay costs together accounted for about 25 percent of the total estimated cost.

The cost related to HM crashes is considerably higher than that for incidents. **Table 2** shows a breakdown of the costs of HM crashes indicated by Phase 1 of this study as compared to those indicated by HMIS. This study has developed a more comprehensive assessment of the costs associated with HM crashes and incidents.

No-spill crashes account for 58 percent of the estimated costs; this is primarily because there are almost twice as many no-spill crashes as spill crashes. There are no cleanup costs included in the product or environmental damage costs; however, no-spill crashes led to considerably more injuries and slightly more fatalities than spill crashes.

Table 1.
Impact Case Example.

October **29, 1996,** *4:50* **a.m., near Kirkersville,** ***OH.*** **A tanker truck, traveling eastbound on I-70, went into the median and rolled onto its side. The cargo tank was carrying 6,800 gallons of acetone. Less than 100 gallons of the hazardous cargo were released through the tank's pressure relief valve. The driver was taken to the hospital with injuries. Both the eastbound and westbound lanes of I-70 were closed at 5 a.m., and were expected to open by 2 p.m. An environmental contractor was called to clean up the spill.**

	Field	Value
HM Information	**Commodity**	**Acetone**
	Class	3; Flammable - Combustible Liquid
	Quantity Spilled	Less than 100 gallons
Accident Information	Location	I-70 eastbound, near Kirkersville, OH (Rural community)
	Fatalities	0
	Injuries	1 person, $400,000
	Evacuation	0
Damages	Product Loss	$500
	Carrier Damage	$2,000
	Public/Private property damage	$0
	Decontamination/cleanup	$1,500
	Incident Delay	$83,025
	Environmental Damage	$88
Total Estimated Cost		**$487,113**

Researcher
This study was performed by Battelle, 505 King Avenue, Columbus, Ohio 43201. Contract No. DTFH61-98-C-00060.

Distribution
This Tech Brief is being distributed according to a standard distribution. Direct distribution is being made to the Resource Centers and Divisions.

Availability
The study final report will be available from the National Technical Information Service, Telephone: (703) 605-6000.

Key Words
hazardous materials, risk assessment, incident, hazardous materials incident, Hazardous Materials Information System.

Notice
This Tech Brief is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The Tech Brief provides a synopsis of the study's final publication. The Tech Brief does not establish policies or regulations, nor does it imply FHWA endorsement of the conclusions or recommendations. The U.S. Government assumes no liability for its contents or their use.

U.S. Department of Transportation
Federal Highway Administration

June 1999
Publication No. FHWA-MCRT-99-013

Table 2.
Comparison of 1996 **HMIS** Transportation Crash Impact Estimates and Phase I Comprehensive Crash Impact Estimates, Class 3 HM Shipments.

Impact:	HMIS	Phase I Comprehensive
Cleanup	$6,552,972	$16,660,000
Product Loss	$547,789	$1,862,000
Carrier Damage	$6,155,936	$51,948,000
Property Damage	$1,572,115	$8.513.700
Environmental Damage	N/A	$882,000
Injury	$3,000,000	$190,600,000
Fatality	$6,000,000	$134,000,000
Evacuation	$647,000	$1,950,000
Incident Delay	N/A	$52,874,357
Total Costs	$24,475,812	$459.290.057

Impact estimates related to the fact that the cargo is HM are important for both the current analysis and any future risk assessments or rnodeling. An analysis of the crash and incident impacts determined which impacts were the result of the HM cargo being shipped. About $122,800,000 of the $459,000,000 in impact costs from HM crashes can be directly related to the hazardous nature of the cargo. This represents about 30 percent of the impact costs for the major Class 3 crashes and incidents estimated for 1996.

Conclusions and Future Research

This study demonstrated a process to evaluate the full impacts of HM crashes/incidents by sampling a single HM class for one year. By characterizing the shipment impacts for 1 year of Class 3 HM shipments the study demonstrates a process that can be applied to determining the impacts of other HM classes as well as for non-HM shipments.

Specifically, the study has demonstrated the feasibility of obtaining data and conducting analysis in the following areas:

- Estimation of the number of crashes and incidents for 1 year.
- Estimation of the type and magnitude of impacts from crashes and incidents.
- Identification of data needed for the full risk assessment.

The report provides a solid beginning for the comparative risk assessment scheduled for the second phase of this study which is scheduled for completion in fiscal year 2000.

Reference

Grenzeback, Lance R., et al., "Urban Freeway Gridlock Study: Decreasing the Effects of Large Trucks on Peak-Period Urban Freeway Congestion," Transportation Research Record, No. 1256, 1990.